POHUTUKAWA x RATA

Variation in Metrosideros (MYRTACEAE) on Rangitoto Island, New Zealand

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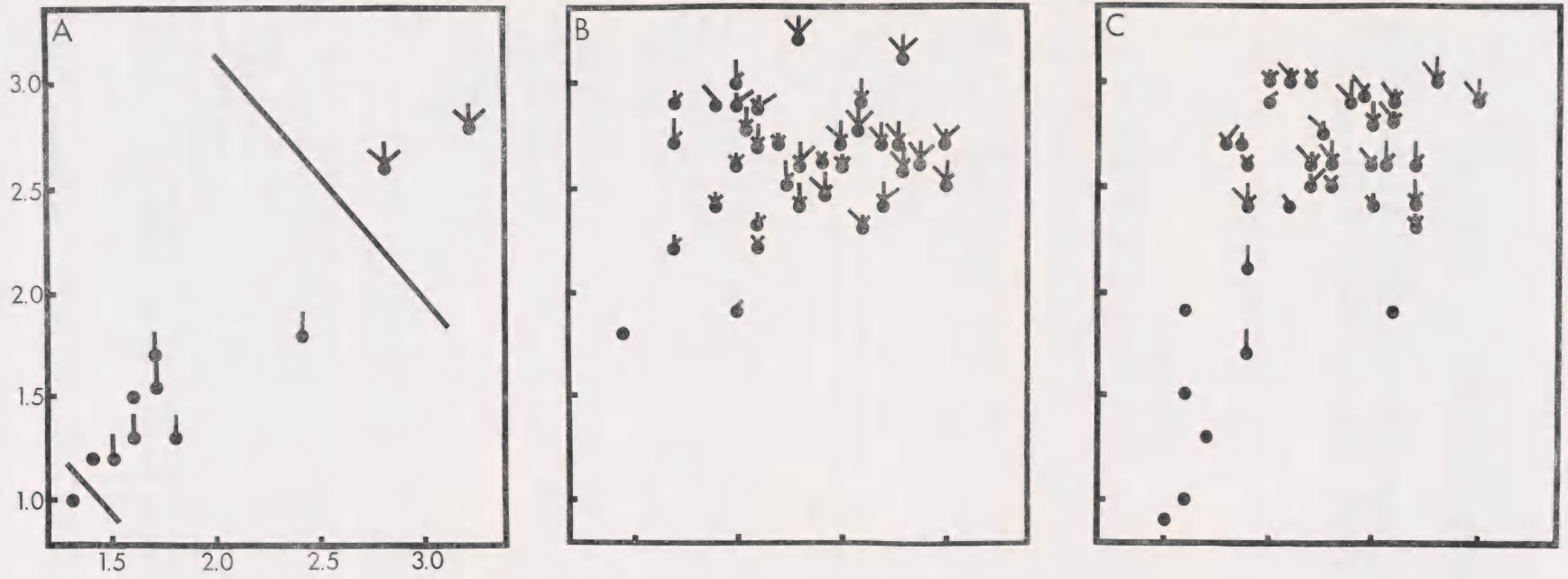
Abstract.

Attention is drawn to certain recent papers describing new techniques for the study of variation in plants. One of these techniques, the pictorialized scatter diagram is illustrated, using specimens of *Metrosideros spp.* from a known hybrid swarm on Rangitoto Island, and the results from an ordinary herbarium collection and two mass collections are contrasted.

The method by which a pictorialized scatter diagram is developed is explained in Anderson (1949 and 1952) and Anderson and Gage (1952). Anderson (1949 and in press) has also explained the ecological, genetical and mathematical criteria upon which scatter diagrams are based. Stebbins (1953) pointed out that the method is "by far the best yet devised for making the observer aware of a pattern of variation in respect of three or more characters which are varying simultaneously." He added, "to be sure the selection of characters to study and of their arrangement on the diagram are based on just as strictly subjective judgment as are the descriptions of the traditional systematist. But once the method is learned it is, like every other scientific method, a valuable tool for making complex natural phenomena relatively clear to the human mind without seriously distorting them." The same author also remarked that the method "has the advantage of being repeatable."

The figures listed in the three tables below are the measurements of certain characters of specimens of *Metrosideros spp.* (Myrtaceae) gathered on Rangitoto Island, a circular volcanic cone situated in Hauraki Gulf at the entrance to Auckland Harbour. The measurements in the first table were made on specimens collected by various botanists over the last eighty years and preserved in the Cheeseman Herbarium at the Auckland Museum. The measurements in the second and third tables were made on specimens gathered as "mass collections" by the writer immediately prior to the preparation of this paper. These collections are also preserved at the Auckland Museum.

Measurements of leaf width and stamen length were chosen as abscissa and ordinate respectively because they varied consistently and could be measured accurately. The other three characters, leaf length, internode length and calyx length, were indicated by rays from each dot on the scatter diagram. Limits of the three grades of each of these characters were chosen so that extremes associated with higher values for leaf width and stamen length are indicated by long rays and extremes associated with lower values for leaf width and stamen length are represented by no rays.



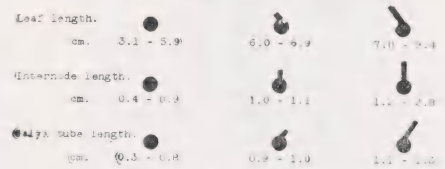
Pictorialized scatter diagrams of three samples of a hybrid swarm between *Metrosideros excelsa* (Pohutukawa) and *M. robusta* (Rata) on Rangitoto Island, New Zealand.

a. Ordinary herbarium specimens in the Auckland Museum.

b. Mass collection from the southern side of the island.

c. Mass collection from the eastern side.

Horizontal axis, leaf width; vertical axis, stamen length; three other characters are indicated by rays:—



At one extreme, the upper right-hand corner of each diagram, are the specimens with leaves which are markedly long and broad, and with stamens, internodes and calyx tubes which are markedly long. On the diagram of herbarium specimens (diagram A) the two dots enclosed by a line in the upper right-hand corner are specimens belonging to the species formerly known as *Metrosideros tomentosa* Rich. but now known as *M. excelsa* Sol. ex Gaertn. and commonly called pohutukawa or Christmas tree. One of these specimens was collected by Kirk on the Waitemata in December, 1874, and the other was gathered by the writer in a remnant of coastal scrub on his property at Blockhouse Bay this year. Both are similar to specimens collected on the southern slope of Rangitoto Island and shown in the extreme upper right-hand corner of diagram B.

At the other extreme, the lower left-hand corner of each diagram, are the individuals with leaves which are markedly short and narrow, and with stamens, internodes and caylx tubes which are markedly short. On the diagram of herbarium specimens (diagram A) the dot enclosed by a line in the lower left-hand corner is a specimen belonging to the species known as *M. robusta* A. Cunn. and commonly called rata. This specimen was collected by Kirk at Mahurangi about 1870 and is similar to specimens collected on the eastern slope of Rangitoto Island and shown in the extreme lower left-hand corner of diagram C.

Metrosideros excelsa and *M. robusta* are distinguished readily by the leaves of the former being tomentose beneath and the leaves of the latter being glabrous, by the stamens of the former being crimson and the stamens of the latter being dark scarlet, and so on. The characters used in the diagrams, however, were those which could be measured most easily in the field.

Individuals which connect *M. excelsa* and *M. robusta* were described by Kirk (1899) as *M. robusta* var. *intermedia* from specimens collected at Rangitoto Island. Carse (1927) described plants intermediate between *M. excelsa* and *M. robusta* from Lake Taupo, Bank of Whau and Titirangi as x *M. sub-tomentosa* nov. hyb., and Oliver (1928) adopted this name instead of *intermedia* "under the authority of a rule which states that the first name used in a specific sense must stand." In terms of Article H. 1 of Appendix II of the 1952 Code of Nomenclature the intermediates will be known in future as *Metrosideros* x *sub-tomentosa* Carse (= *Metrosideros excelsa* x *M. robusta*), if a name is required for them.

The significance of the three scatter diagrams is clear.

1. They show a high degree of correlation among the characters employed, and support the existing taxonomic arrangement.

2. They show the superiority of mass collections over ordinary herbarium collections. On this subject I cannot do better than quote Anderson (1941). "The information derived from a study of mass collections is useful in two ways. It will, in the first place, aid the systematist in cataloguing the various entities involved, species, varieties, forms, etc. While it may raise more new questions than it may solve old ones, it will aid in the production of monographs whose categories are more accurately adjusted to the variation patterns of their particular genera. Mass collections have for some time been customary in avian

taxonomy (see, for instance, Mayr[3]), and Kinsey, in a series of brilliant monographs[4], has shown their superiority in insect systematics. If taxonomy were to be nothing more than cataloguing, and if taxonomists were to confine themselves to the problems raised by their herbaria, mass collections would still be a useful adjunct to herbarium technique and in many critical groups would provide more efficient working material, even when their special difficulties of collecting and filing are considered.

There is no reason, however, why taxonomy should be content to cultivate such a narrow field. If collectors and herbarium administrators could be persuaded to encourage mass collections, critically made and carefully assembled, a second kind of problem could be investigated in herbarium material. The description and analysis of geographical trends in variation, the delimitation and interpretation of centres of variation, the establishment and analysis of variation patterns in different genera and families, are only a few of the problems that might well be investigated. It is already possible to correlate information from the field of taxonomy with that from cytogenetics. The time is not far distant when the biochemist of the germplasm will also turn to the taxonomist for morphological evidence derived from studying the products of the germplasms. To speak with authority on such questions taxonomists will need to refine their biological as well as their bibliographical techniques."

In this very minor example of the technique, diagrams B and C show that the prevalence of individuals closely resembling Kirk's specimen of *M. excelsa* from the Waitemata and my collection from Blockhouse Bay is greater in the sample from the southern side of Rangitoto Island (diagram B) than it is in the sample from the eastern side (diagram C). In the sample from the eastern side of the island none of the specimens is identical with Kirk's specimen of *M. excelsa* from the Waitemata or my collection from Blockhouse Bay, but there are several individuals which closely resemble Kirk's specimen of *M. robusta* from Mahurangi. Further fieldwork, using ecological techniques, would be required to verify these distribution patterns.

General: Cockayne and Allan (1927) recognized ten classes and grades of individual polymorphy and seven classes and grades of polymorphy in groups of related individuals. The two authors considered hybridism to be the most prolific source of diversity, however, and emphasized that in the majority of cases there occur amongst hybridising species not a few intermediate individuals but a multitude of forms producing a motley "swarm." In 1934 they published an annotated list of 491 groups of wild hybrids in the New Zealand flora and expressed the opinion that of these 396 were established beyond reasonable doubt. They recognized the hybrids as such by field studies, supplemented by observations of cultivated specimens, and in several instances Allan bred plants similar to suspected wild hybrids by controlled crossings of the putative parents.

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[3]Mayr, Ernst. Speciation phenomena in birds. Amer. Nat. 74: 249-278. 1940.

[4]Kinsey, Alfred C. The gall wasp genus *Cynips*. A study in the origin of species. Indiana Univ. Studies, 84-86: 1-577, 1930; The origin of higher categories in Cynips. Indiana Univ. Publ. Sci. Ser. 4: 1-334, 1936.

Evidence relating to only some of the 491 groups has been published, however, and in herbaria other than that of the Botany Division, D.S.I.R., Wellington, where most of the collections of Cockayne and Allan are preserved, there are few representative collections of the hybrid swarms. In other words, much work remains to be done, on the foundations provided by Cockayne and Allan, especially as Anderson (1949) has emphasized that the almost imperceptible introgression of one species into another, by repeated back crossing of the hybrids to one or both parents, may be of far greater biological significance than hybridisation which leads to "bizarre hybrid swarms, apparent even to the casual passer-by." Valuable new techniques for this work, the study of introgression and the further analysis of variation in the New Zealand flora, are mass collecting (Anderson, 1941 and 1943), inclusive herbarium sheets (Anderson, 1951 and 1952), and pictorialized scatter diagrams and similar methods of polygraphic analysis (Anderson, 1949 and 1952). The value of these methods in the study of cultivated plants (Anderson, 1952; Stebbins, 1953) and the possible use of the pictorialized scatter diagram in other fields of research (e.g., archaeology) must also be mentioned.

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TABLE 1.

Specimens in the Cheeseman Herbarium, Auckland Museum.

No.	Leaf length.	Leaf width.	Internode length.	Stamen length.	Calyx length.
Kirk, 1874	7.7	2.8	2.5	2.6	1.1
Kirk, c. 1870	3.5	1.3	0.8	1.0	0.7
Kirk, 5593	4.2	1.6	0.6	1.5	0.7
Cheeseman, 5574	3.4	1.6	1.8	1.3	0.7
Cheeseman, 5575	3.2	1.5	2.4	1.2	0.8
Cheeseman, 5576	3.4	1.4	0.7	1.2	0.7
Cranwell, a	5.2	1.8	1.5	1.3	0.7
Cranwell, b	3.6	1.7	1.2	1.6	0.7
Cranwell, c	5.2	2.4	2.4	1.8	0.6
Cranwell, d	4.5	1.7	1.3	1.7	0.7
Cooper, *36092*	8.3	3.2	1.8	2.8	1.1

TABLE 2.

Mass collection from the southern slope of Rangitoto Island between reference points *377666* and *375674* on the N.Z. Lands and Survey Motutapu map of 1943 (1: 25,000 series).

	Leaf length.	Leaf width.	Internode length.	Stamen length.	Calyx length.
1	6.7	2.2	1.1	2.7	1.0
2	6.5	2.7	1.3	2.4	1.1
3	5.1	2.0	1.6	3.0	0.9
4	6.1	2.0	1.0	2.6	1.0
5	6.7	2.1	1.3	2.7	0.9
6	6.4	2.3	1.5	2.4	0.9
7	6.8	2.3	1.4	2.6	1.1
8	6.0	1.9	1.1	2.4	1.0
9	3.7	1.4	0.4	1.8	0.7
10	5.5	1.7	1.2	2.7	1.0
11	6.2	2.1	1.2	2.8	1.0
12	5.5	1.7	1.1	2.9	1.0
13	8.1	2.3	1.2	3.2	1.3
14	5.9	2.0	1.1	2.9	1.1
15	7.5	2.5	1.4	2.7	1.0
16	9.1	2.8	1.5	3.1	1.1
17	7.7	2.7	1.2	2.7	1.0
18	7.4	2.8	1.3	2.6	1.0
19	7.0	2.6	1.6	2.8	1.2
20	6.3	2.6	1.2	2.9	1.0
21	7.4	2.6	1.0	2.3	1.0
22	7.0	1.9	0.9	2.9	0.8
23	6.2	2.0	1.1	2.9	1.1
24	7.7	3.0	1.3	2.5	1.0
25	6.9	2.5	1.1	2.7	1.0
26	7.5	3.0	1.1	2.7	1.1
27	6.9	2.4	0.9	2.6	1.0
28	6.1	2.1	0.9	2.2	0.9
29	5.8	2.1	1.1	2.3	1.0
30	5.6	2.3	1.3	2.5	0.9
31	7.0	2.7	1.5	2.7	1.0
32	4.4	2.0	0.6	1.9	0.9
33	7.3	2.4	1.2	2.5	1.0
34	4.9	1.7	1.0	2.2	1.0
35	7.3	2.8	1.5	2.6	1.1

TABLE 3.

Mass collection from the eastern slope of Rangitoto Island between reference points 382688 and 394692 on the N.Z. Lands and Survey Motutapu map of 1943 (1: 25,000 series).

	Leaf length.	Leaf width.	Internode length.	Stamen length.	Calyx length.
41	6.7	2.5	1.2	2.8	1.0
42	3.1	1.5	0.6	0.9	0.5
43	6.8	1.8	0.9	2.7	1.1
44	4.5	1.7	0.8	1.3	0.6
45	5.9	2.6	0.8	1.9	0.8
46	5.7	2.0	0.8	2.9	0.9
47	7.6	2.5	0.9	2.6	0.9
48	7.3	1.9	1.3	2.4	0.9
49	3.8	1.6	0.7	1.5	0.8
50	6.4	2.7	1.0	2.3	0.9
51	6.1	2.1	0.9	2.4	0.7
52	7.2	2.2	1.1	2.6	1.0
53	6.6	2.3	0.8	2.5	1.0
54	7.9	2.8	1.9	3.0	0.9
55	7.0	2.4	1.2	2.9	0.8
56	3.4	1.6	0.6	1.0	0.6
57	4.9	2.5	1.6	2.6	0.9
58	6.3	2.7	1.3	2.4	0.9
59	8.2	2.6	1.1	2.9	0.9
60	9.4	2.5	1.1	2.8	1.0
61	5.5	2.7	1.2	2.6	0.9
62	4.7	1.9	1.4	1.7	0.7
63	4.8	1.6	0.7	1.9	0.5
64	5.5	2.2	1.1	2.5	1.1
65	8.6	3.0	1.3	2.9	1.0
66	6.9	2.0	1.1	3.0	0.9
67	7.5	2.4	0.9	2.9	1.0
68	7.0	2.1	1.1	3.0	0.9
69	7.2	2.3	1.3	2.6	1.0
70	7.6	2.3	1.0	2.7	0.8
71	6.2	2.2	0.9	3.0	1.0
72	4.0	1.8	1.0	2.7	0.7
73	6.3	1.9	0.8	2.6	1.0
74	6.3	2.5	1.1	2.4	0.8
75	5.3	1.9	1.3	2.1	0.8

Notes—

1. All measurements are in cm.
2. Nos. 36-40 were not used in the numbering of mass collections.
3. "Leaf length" and "leaf width" were measured on leaves at the second node beneath the apex of a mature woody branchlet bearing the flowering shoot.
4. "Internode length" refers to the third internode from the apex of the mature woody branchlet bearing the flowering shoot.
5. "Calyx tube length" refers to the calyx of a fully-open flower in the centre of a cyme.